Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 12; October-December 2014 pp. 169-171

http://www.krishisanskriti.org/jbaer.html

Design and Fabrication of a Hand Winnowing Fan to Convert Human Muscle Energy into Electrical Energy

Sharad Kumar Chandrakar[1], Amit kumar Subudhi[2], Ambrish Tiwari[3], Bikash Mandal[4], Shruti Tiwari[5] and Sidharth Tiwari[6]

[1,2,3,4,5,6]SSGI Bhilai
E-mail: [1]shrd15@gmail.com, [2]amitkrsubudhi@gmail.com, [3]ambrish.korba@gmail.com, [4]myselfbikash20@gmail.com, [5]ambrish.korba@gmail.com, [6]gkpal145@gmail.com

Abstract: *In this paper authors, design, fabricate and experimentally studied a Hand Winnowing Fan to convert human muscle energy into electrical energy. It has unique features of using human power as prime mover for electric generator. Muscle energy in form of high-torque low-speed can be converted into low-torque high-speed through speed increaser to energize the electric generator. The electricity generated is stored in the batteries of different capacity and used when required. This equipment is emission free, low cost and has long life. Also this equipment needs less maintenance and any person can run either skilled or unskilled.*

Keywords: *Muscle energy, hand winnowing fan, electric generation, dc battery.*

1. INTRODUCTION

Over 1.5 billion people rely on kerosene for light. Lack of suitable home lighting is directly linked to illiteracy, poverty and health problems. The current widespread burning of kerosene also results in environmental pollution. It is very difficult and very costly to available grid power everywhere specially at remote isolated communities in developing countries. There are many renewable power sources like solar power, wind power, hydropower, bio-energy, geo-thermal power, tidal energy etc, but all have their limitations. Although from beginning of mankind human have been doing for domestic works, but the electricity generation by muscle power is a novel technology [1-9].

Human power is a work or energy that is produced from the human body. It can also refer to the power (rate of work per time) of a human. Power comes primarily from muscles, but body heat is also used to do work like warming shelters, food, or other humans. A trained cyclist can produce about 400 watts of mechanical power for an hour or more, but adults of good average fitness average between 50 and 150 watts for an hour of vigorous exercise. A healthy well-fed laborer over the course of an 8-hour work shift can sustain an average output of about 75 watts. The yield of electric power is decreased by the efficiency of the human-powered generator [1]

The device called hand winnowing fan comprises of a mechanical link means provided with an extended handle to transmit muscle power in form of high-torque low-speed; a gear system with an input shaft mounted with 100 teeth gear and an output shaft mounted with 20 teeth gear for converting muscle power received from a mechanical link in the form of a high-torque low-speed to low-torque high-speed; belt and pulley systems which is connected to the output shaft of the gear system for transmitting mechanical energy to generator; generator to convert mechanical energy into electrical energy; and a storage system. The prime mover is preferably at least one human.

2. FABFRICATION DETAILS

(i) Muscle Power: The authors' main object is to use the muscle power for generating electricity for domestic use. The two person of 51 kg and 55 kg of age 22 year were worked alternate as a energy source.

(ii) Hand Winnowing Fan: Hand Winnowing Fan has a set of spur gears housed in a frame of mild steel angles. The gear system with an input shaft mounted with 100 teeth gear and an output shaft mounted with 20 teeth gear for converting muscle power received from a mechanical link in the form of a high-torque low-speed to low-torque high-speed. The shafts are supported by ball bearings. Bearings are fastened on tie-bars which are welded on frame. The spur gears are made of mild steel.

Fig. 1: Side and Front view of hand winnowing fan.

(iii) Belt and Pulley transmission unit: According to Indian Standard Code (IS: 2494-1974), the A type of belts are selected which has power ranges 0.7kW–3.5 KW.[10] There are two set of pulley and belt system. One pulley of 12 inch is mounted on the output shaft of the gear system and counter pulley of 3 inch is mounted on shaft three thereby stepping up the speed in the ratio 1 : 4 when connected with belt. Another pulley of 18 inch is mounted on shaft three and counter pulley of 3 inch is mounted on car alternator thereby stepping up the speed in the ratio 1:6 when connected with belt.

(iv) Generator: In this experimental study authors select the car alternator to generate electricity. Lucas-TVS car alternator of 12V and 40 AH is used. Car alternator needs high rpm to work efficiently. It produces constant voltage but current depends on rpm and produce high as rpm is high. The direction in which the alternator is oriented to spin does not affect its output power. The alternators rotor can be rotated either clockwise or counter clockwise and achieve the same output values.

(V) Storage system: In this experiment a typical 12V, 40AH Lead-acid automotive battery is used. An automotive battery is a type of rechargeable battery that supplies electric energy to an automobile. Charging time depends on the capacity of that battery and the resting voltage of that battery when you begin to charge it.

3. FABRICATION AND PROCEDURE

In the fabrication is done very carefully because there are three shafts which are supported by ball bearing. The bearing covers are fitted with the help of nut and bolt on the mild steel ties, which are welded on the frame. Pulleys are fitted by means of nut, bolt and keys by drilling holes on the shafts and on pulley houses. Hand Winnowing Fan has a set of spur gears housed in a frame of mild steel angles. The gear system with an input shaft mounted with 100 teeth gear and an output shaft mounted with 20 teeth gear for converting muscle power received from a mechanical link in the form of a high-torque low-speed to low-torque high-speed. One pulley of 12 inch is mounted on the output shaft of the gear system and counter pulley of 3 inch is mounted on shaft three thereby stepping up the speed in the ratio 1 : 4 when connected with belt. Another pulley of 18 inch is mounted on shaft three and counter pulley of 3 inch is mounted on car alternator thereby stepping up the speed in the ratio 1:3 when connected with belt and alternator is fabricated on the frame with the help of mechanical linkage.

Authors select the car alternator for generating electricity. Car alternator starts to work about 2000 rpm. If human rotates the starting gear having 100 teeth with average 20 rpm then the meshing gear having 20 teeth rotates with 100 rpm. Since pulley one is fabricated in same shaft hence it also rotates at 100 rpm. The counter pulley of 3 inch is mounted on shaft three thereby stepping up the speed in the ratio 1: 4 when connected with belt so that it rotates at 400 rpm (100 * 4). The third pulley of 18 inch is mounted on same shaft with 3 inch pulley; it has the same speed of 400 rpm. The counter pulley of 3 inch mounted on car alternator thereby stepping up the speed in the ratio 1: 6; hence the car alternator rotates at 2400 rpm. [11]

20*5*4*6=2400 rpm.

The system is tested by means of human power for many times and it is recognized that the initial force (torque) to rotate alternator at idle speed is very low, it can easily operated by using single hand. Before staring the experiment the alternator is connected with battery and ampere meter is jointed in series. The mechanical link handle is fitted with the first gear of hand winnowing fan by means of nut-bolt at one end and another end is free to applied force. When human applied force through arm at handle the first gear start rotate and drive the meshing gear as well as pulley one. The pulley one transmits power to counter pulley and so on. At the starting the rpm is very low hence the alternator was not responding but as well as speed is increasing the alternator start to generating power. Human were need to applied force to maintain average speed. The rpm and generated volt & current were taken after every minute. First time the battery was 50% discharge and it took approximate 1.5 hours to charge fully (multimeter indicate 12.6V). Second time battery was 25% discharge and it took 2.5 hours. The experiment also done at 60%, 70% and 80% state of charges and time taken to charge fully has taken. Parallel the time required to discharge the battery at different percentage when 120 watt AC load (two 60W bulb) is subjected to battery through inverter had taken. The experiment had done 9 times.

Fig. 2 : Human powered winnowing fan for generating power.

4. RESULTS AND DISCUSSION

The humans' effort and arm speed depend on the load subjected. The readings are taken after every minute within one hour and results are shown in graphs. Speed vs. Time graph shows that average speed of alternator is mostly changes, but it is within the ideal working range of alternator. Speed vs. Current shows that at low rpm at starting, it is not generating current, but as well as rpm is increasing and reaches to ideal working rang alternator producing high value of current. Experimental result shows that alternator is not generating current as expected and specified by company due to very quick changes in speed. Voltage vs. RPM proves to be completely unchanging as expected and alternator generates constant voltage of 12V as specified after reaching ideal speed. State of Charge vs. Charging Time shows that battery takes more time to charge as less as state of charging is low for charging same amount. Fully charged battery shows 12.6V. Fully charged battery takes the approximately 2 hours to discharge 50% when 6 bulb of 60Watt DC is loaded. Since alternator takes initial current to energize, the battery must not be discharge completely. Lighting Time of 6 CFL bulb of 25W for different state of discharge is shown in graph. Results shown that battery and inverter have more than 75% efficiency as expected. Finally result was found that at least 4 hrs (6pm–10pm) the home will be lighted using that system.

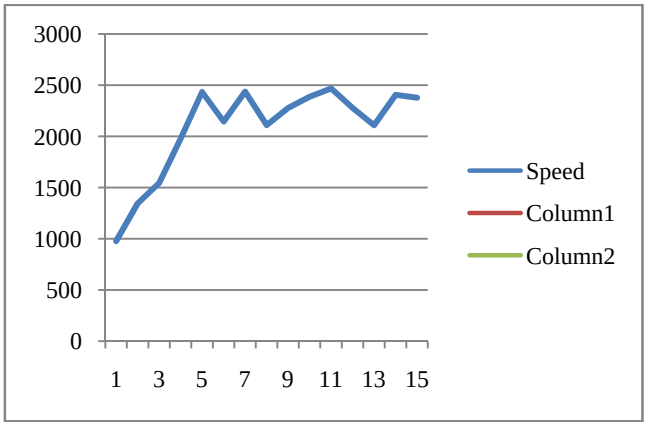

Fig. 3: Time (in minutes) vs. RPM of alternator.

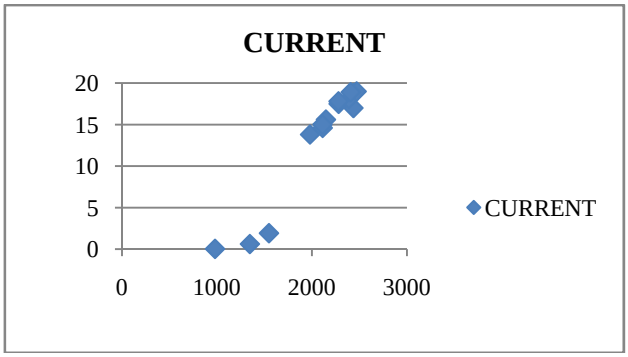

Fig. 4: Alternator RPM vs. Current in Amp.(DC)

5. CONCLUSIONS

The present work provides a mechanical device for producing electricity for home lighting using the biological energy of the muscles of human. The project goal was to design, fabricate and experimentally studied of mechanical device to charge a battery with a 12 volt DC output for 1.5 billion people who rely on kerosene for light. This goal had to be met within the constraints of a low production cost and high safety. The project has to offer a durable product with relatively good efficiency. This is also concluded that fabricated mechanical device is itself a very small scale industry for charging batteries at rural and isolated areas.

6. ACKNOWLEDGMENT

Authors would like to thank to the researchers/academicians whose works have been cited directly or indirectly in this paper and mechanics who helped in this project. Authors also wish to thank to Shri I P Mishra (President SSGI Bhilai), Dr P B Deshmukh (Director SSGI Bhilai), Prof. J K Tiwari (HOD Mechanical SSGI Bhilai).

REFERENCES

[1] Fuller R. J., Aye LU,2012, "Human and animal power–The forgotten renewables" Renewable Energy 48 (2012) 326-332.

[2] Draught animals. From (http://www2.sjsu.edu/faculty/watkins/animalpower.htm) Metric conversion by Tim Lovett.

[3] Nagendra Pathak, Pushpito Kumar Ghosh, Sohan Lal Daga, Virendra J ayantilal Shah, Sanat Natubhai Patel "Animal powered mechanical device for water destination" US 7,387,728 B2. July 17, 2008.

[4] Maximo Gomez-Nacer, "Animal powered electricity generator" Patent no - US 2005/0161289 A1, July 28, 2005.

[5] Udayasankar Devanaboyina, "System for driving an animal powered vehicle" Pub. No: US 2011/0308868 A1, Des 22, 2011.

[6] FAO. Draught animal power–an owerview. UN Food and Agriculture Organisation; 2010.

[7] Wilson RT. The environmental ecology of oxen used for draught ower. Agriculture,ecosystems and environment 2003;97:211-37.

[8] FAOSTAT. Production; live animals. Available from http://faostat.fao.org/;2011 [accessed 13.12.11].

[9] Pearson A. Animal power: matching beast and burden. Appropriate Technology 1991 ; 18 (3): 11-4.

[10] Bhandari, V. B., 1994, "Design of Machine Elements," Tata McGraw-Hill.

[11] Ratan S S., "Theory of Machines," Tata McGraw-Hill.